VIRGINIA
ADVANCED ENERGY ECONOMY

Carbon Mitigation & Advanced Energy in Virginia

Comments by Virginia Advanced Energy Economy regarding the Carbon Mitigation Rules Proposed by the Department of Environmental Quality

April 9, 2018

About Virginia Advanced Energy Economy

Virginia Advanced Energy Economy (Virginia AEE) is a coalition of businesses that seek to make the Commonwealth's energy more secure, clean, and affordable, bolstering Virginia's economy. Virginia AEE aims to drive the development of advanced energy by identifying growth opportunities, removing policy barriers, encouraging market-based policies, establishing partnerships, and serving as the voice of innovative companies in the advanced energy sector.

Executive Summary

Virginia Advanced Energy Economy (Virginia AEE) supports the draft regulation put forward to establish a CO_2 budget trading program in the Commonwealth. The proposed regulation will help to make Virginia's energy more secure, clean, and affordable – central goals of our business coalition – bolstering the state's economy while reducing emissions. Furthermore, we support the ability of the proposed regulation to integrate into other carbon markets. Integration with other states and regions will help Virginia achieve greater efficiencies and further reduce emissions.

Utilizing the State Tool for Electricity Emission Reductions (STEER), an integrated resource-planning tool tailored specifically to identify the least-cost way for Virginia to implement CO_2 emission regulations, Virginia AEE analyzed multiple possible compliance pathways. We determined that, utilizing a diverse portfolio of advanced energy resources – including both renewables and energy efficiency – the state could reduce emissions by over 13.3 million tons between 2020 and 2030 at little to no cost, far surpassing the emission reduction targets in the draft regulation.

Furthermore we found that, by employing a combination of advanced energy technologies, not only could Virginia surpass its mitigation target but also that it could do so while maintaining, even lowering, electric rates. Meeting these targets through advanced energy, according to our analysis, would create 30,000 to 40,000 new jobs in Virginia, spur $1.3 to 4.6 billion in new in-state investment, and generate $80 to 420 million in new state and local tax revenue. A CO_2 budget trading program will benefit the Commonwealth's environment and economy, with gains for a variety of constituencies, from small businesses to residents, and farmers to rural communities.

To further strengthen the proposed rule, we recommend regulators consider a number of measures: the Va. Department of Environmental Quality (DEQ) should set the 2020 baseline at no more than 33 million tons of CO_2 (as deeper reductions can be readily achieved with little or no cost); the annual reduction in the cap should be accelerated from 3% to 4%; the allowance allocation method should be reformed to allocate permits to all generating resources over 25 MW, not just fossil-fired generators; the set-side for the Department of Mines, Minerals, and Energy (DMME) should be doubled; the CHP exemption should be reformed; the state should utilize the National Energy Efficiency Registry to administer and evaluate energy efficiency programs; and regulators should be careful not to disrupt voluntary emission reduction markets.

Virginia AEE appreciates the opportunity to comment on the draft rule. We applaud the progress that the Commonwealth has made and look forward to collaborating with regulators, policymakers, and other stakeholders to create a functional, cost-effective carbon mitigation market in Virginia.

Introduction

In 2017, then-Governor McAuliffe issued Executive Directive 11 (ED 11), which instructed the Director of Virginia's Department of Environmental Quality (DEQ), in coordination with the Secretary of Natural Resources, to:

Develop a proposed regulation for the State Air Pollution Control Board's consideration to abate, control, or limit carbon dioxide emissions from electric power facilities that:

> *Includes provisions to ensure that Virginia's regulation is "trading ready" to allow for the use of market-based mechanisms and the trading of carbon dioxide allowances through a multi-state trading program; and*
>
> *Establishes abatement mechanisms providing for a corresponding stringency to limits on carbon dioxide emissions imposed in other states with such limits.*

Virginia AEE strongly supports the draft CO_2 Budget Trading Program regulation, which the ED 11 process has generated. Staff for Advanced Energy Economy (AEE), with which Virginia AEE is affiliated, and the AEE Institute have actively engaged in relevant regulatory discussions in Virginia over the past three years, participating in and presenting to a variety of stakeholder and working groups, as well as submitting public comments.

The comments that follow are broken out into three sections. **Section One** briefly describes the business case for such a regulatory regime. It also provides an overview of the advanced energy technologies that can help the Commonwealth meet emission reduction targets.

Building on this technology overview, **Section Two** reviews three potential compliance scenarios. To provide DEQ and other interested parties with constructive insight and analysis, Virginia AEE has employed an updated version of the State Tool for Electricity Emissions Reductions (STEER) to model these scenarios. Using STEER we have analyzed the potential emissions, rate, and economic impacts of these scenarios, illuminating the implications of various choices around energy development and policy. This modeling analysis shows that Virginia can meet and surpass its mitigation targets while maintaining or even lowering electricity rates and growing the Commonwealth's economy.

Finally, drawing on the results of this modeling, as well as AEE's breadth and depth of experience in the industry, **Section Three** advances a series of recommendations. These recommendations are intended to make the proposed regulation more effective and enhance Virginia's trajectory toward an advanced energy future.

Section One

The Business Case for Action

As a coalition of businesses operating in the Commonwealth – a number of which are headquartered here – Virginia AEE is deeply invested in the future of advanced energy markets in the state and policies that enable and accelerate the growth of those markets. It has been the experience of our member companies that participation in carbon markets can bolster advanced energy.

Virginia AEE members are also mindful of local impacts, such as flood and storm damage in coastal cities including Hampton Roads, Virginia Beach and Norfolk exacerbated by climate change. By 2030, studies suggest that $17.4B of Virginia property will lie below the mean high-tide line.[1]

Ideally, the Commonwealth would implement a regulatory regime that can interface with existing U.S. carbon markets and be replicated by other states and regions. Such linkages make all the more sense given the interconnected nature of our energy market. As part of the larger mid-Atlantic wholesale power market, PJM, Virginia is already part of a multi-state energy market, so it only makes sense any carbon-trading regime follows suit.

The businesses that comprise Virginia AEE appreciate the efficient price discovery and transparency that a market mechanism allows and the broader regulatory certainty a carbon price creates. Businesses in the energy space plan not only for the quarter or year ahead but also for decades to come – a necessity when considering infrastructure investments and contracts that may extend 20-plus years into the future.

For all of these reasons Virginia AEE supports ED 11 and the Commonwealth's work to develop a carbon mitigation strategy.

Advanced Energy, CO_2 Mitigation & Additional Benefits

Advanced energy encompasses a wide variety of technologies, from zero- and low-carbon-emitting generation resources to energy efficiency, demand response, and battery storage, to name but a few examples. These technologies can and should play an integral role in helping the Commonwealth to reduce its carbon footprint.

AEE has catalogued these technologies to illustrate the array of innovations available to utilities, policymakers, and others as they develop carbon mitigation strategies. The full array of such technologies can be found in the report

[1] https://riskybusiness.org/site/assets/uploads/2015/09/Climate-Risk-in-Southeast-and-Texas.pdf

Advanced Energy Technologies for Greenhouse Gas Reduction.[2] Below are highlighted a handful of such technologies:

- **Renewable Resources:** Renewable energy resources, long a cost-effective means of carbon reduction due to their zero-emission profile, are increasingly cost competitive even before other benefits are taken into account. Based on data from Lazard, a financial advisory and asset management firm, the levelized cost of electricity (LCOE) for utility-scale wind and solar power has declined by 66 percent and 85 percent, respectively, from 2009 to 2016.[3] As these prices continue to decline, utilities and large commercial and industrial energy users, including Microsoft, Facebook, and Amazon, which are highly attentive to energy prices, are integrating more renewable generation into their portfolios. Beyond their cost-effectiveness, utility-scale renewable resources have demonstrated their capability for providing valuable flexibility services to the bulk electric system.[4]

- **Dispatchable Resources:** Dispatchable zero- and low-carbon-emitting technologies include hydroelectric power, biomass, and waste-to-energy. These resources can integrate with variable renewable energy resources and also complement each other both technologically and economically, allowing the electricity system to provide reliable, low-carbon power.

- **Energy Storage:** Energy storage helps integrate renewables, reduces the need for peaking power plants – leading to fewer emissions – and provides ancillary services such as frequency regulation and spinning reserves, allowing thermal units to operate more efficiently and lowering emissions.[5] For example, AES Storage (now Fluence, a joint venture of AES and Siemens) – headquartered in Arlington, VA – developed a 32MW lithium ion battery in West Virginia to pair with a 98 MW wind project. This battery system helped to provide additional reliability to the grid as well as important grid services such as frequency regulation.[6] Electric vehicle (EV) charging infrastructure, if deployed strategically, can also help turn EVs into a storage resource, with similar benefits.

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[2] https://info.aee.net/epa-advanced-energy-tech-report

[3] https://www.lazard.com/media/438038/levelized4cost4of4energy4v100.pdf

[4] For additional information on the flexibility services of renewable resources: https://www.nrel.gov/docs/fy17osti/67799.pdf

[5] California Energy Commission, *Integrated Energy Policy Report* (2011), available at: www.energy.ca.gov/2011publications/CEC4100420114001/CEC41004201140014CMF.pdf

[3] https://www.lazard.com/media/438038/levelized4cost4of4energy4v100.pdf

[4] For additional information on the flexibility services of renewable resources: https://www.nrel.gov/docs/fy17osti/67799.pdf

[5] California Energy Commission, *Integrated Energy Policy Report* (2011), available at: www.energy.ca.gov/2011publications/CEC4100420114001/CEC41004201140014CMF.pdf

[6] http://www.wvcommerce.org/App_Media/assets/doc/energy/WWG/2012/AES4LM4Overview2012.pdf

- **Energy Efficiency:** As of 2014, residential and commercial buildings accounted for over 40% of total U.S. energy use and 74% of electricity consumption.[7] This translates to over $400 billion in annual energy spending, which means efficiency holds the potential for large cost and energy savings, and thus emission reductions. Efficiency can encompass a wide variety of measures, from improvements in building envelopes and HVAC systems to better lighting options, smart thermostats and other connected devices, and changes in the behavior of occupants. Considering just the residential sector, it is estimated that efficiency upgrades could deliver an annual savings of $750 to the average household.[8]

- **Demand Response:** Demand response (DR) entails managing demand in response to price signals or calls from grid operators when the grid is stressed. DR is a cost-effective alternative to using peaking plants or ramping other generation resources, and thus offers emissions benefits. A November 2014 Navigant report found that DR can directly reduce CO_2 emissions by more than 1 percent through peak load reductions and provision of ancillary services, and that it can indirectly reduce CO_2 emissions by more than 1 percent through accelerating changes in the fuel mix and increasing renewable penetration.[9] Neighboring states, including Maryland, Pennsylvania, and New York, are reducing energy costs for their customers through the deployment of utility peak-shaving demand response programs. In New York, where the Ratepayer Impact Measure (RIM) test is used, the utility demand response programs have achieved results as high as 1.89.[10]

In additional to helping Virginia meet emission reduction targets cost-effectively, the integration of advanced energy resources can create a number of other important benefits for energy consumers in the Commonwealth:

- By diversifying Virginia's grid, the integration of advanced energy can help maintain, even improve reliability, as a recent report by the AEE Institute – *Changing the Power Grid for the Better* – notes.[11] Incorporating more renewable energy, fast-ramping generation, demand management techniques, and new resources like energy storage – rather than being reliant solely on baseload resources – creates a reliable foundation for an electric system.

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[7] www.eia.gov/totalenergy/data/monthly/#consumption
[8] www.energystar.gov/ia/partners/publications/pubdocs/2008%204%20pager%203-12-09.pdf
[9] Navigant Consulting. "Carbon Dioxide Reductions from Demand Response." November 25, 2014
[10] Orange & Rockland Utilities, Inc. Annual Report on Program Performance and Cost Effectiveness of Dynamic Load Management Programs. Case Number 144E40423. December 1, 2016
[11] https://info.aee.net/changing-the-power-grid-for-the-better

- Incorporation of advanced energy innovations, such as high voltage direct current (HVDC) transmission, advanced metering infrastructure (AMI), and voltage optimization, can create both direct and indirect benefits to consumers, residents, and industry. HVDC, for instance, can facilitate the integration of renewable generation while reducing line losses 30-50 percent when compared with traditional transmission systems.[12] AMI, meanwhile, provides the utility with greater visibility into its distribution network, reduces the duration of outages, improves distribution system efficiency, enhances the ability to integrate distributed energy resources (such as rooftop solar and energy storage), and provides granular information that utilities, customers and third parties can use in demand response programs and to increase energy efficiency.

- Other distributed resources, such as combined heat and power (CHP), industrial waste energy recovery, and fuel cells can help to reduce grid congestion and increase flexibility while further decarbonizing the energy system. These resources also provide energy consumers with increased choice and control over their energy use, and in many cases deliver cost savings to consumers. DEQ has granted certain CHP units an exemption from the proposed regulation, which is warranted given the significant emissions benefits offered by these systems. EPA has found that a CHP system produces both heat and electricity from a single fuel source with one-half of the emissions of traditional generation.[13]

Due, in part, to the energy legislation (SB. 966) recently passed by the General Assembly and signed into law by Gov. Northam, Virginia is currently poised to take advantage of this range of advanced energy innovations and reap the array of benefits they provide. Virginia AEE and its member companies would be happy to provide additional resources and support as Virginia's utilities, policymakers, and others work to build a 21st century grid that both meets the Commonwealth's carbon goals, maintains reliability, and creates new economic opportunities.

Section Two

How STEER Works

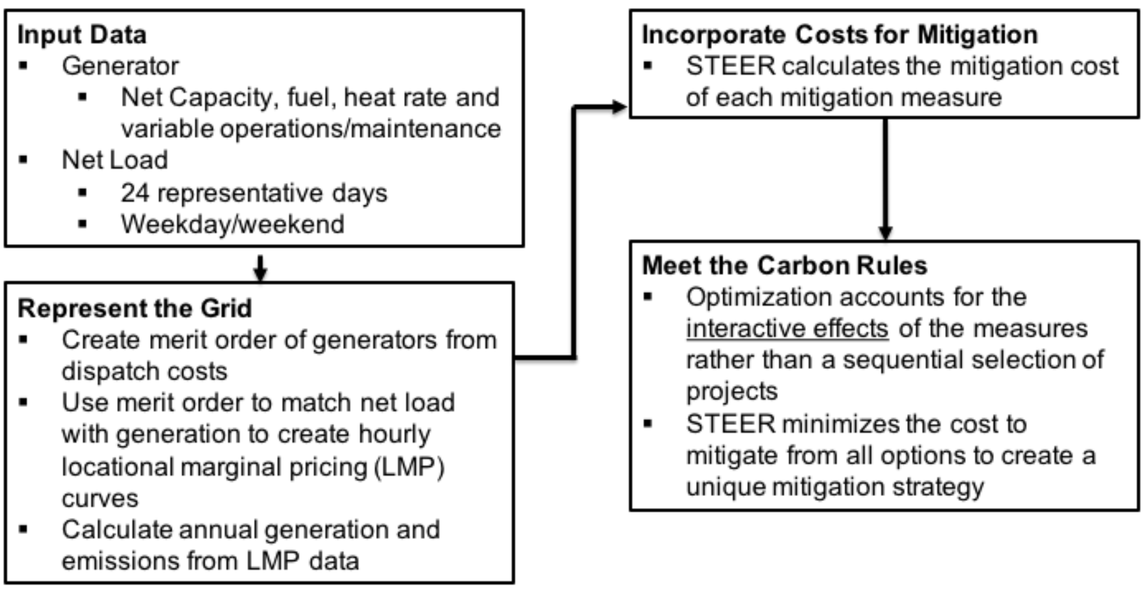
STEER is an integrated resource planning tool tailored specifically to find the least-cost way for a state to implement CO_2 emission regulations. Integrated resource planning is a mathematical method used by utilities and utility regulators

[12] Siemens, High Voltage Direct Current Fact Sheet (Jul. 2012), www.siemens.com/press/pool/de/events/2012/energy/20124074wismar/factsheet4hvdc4e.pdf
[13] U.S. EPA, Feb. 2015, "Fuel and Carbon Dioxide Emissions Savings Calculation Methodology for Combined Heat and Power Systems" (https://bit.ly/2E2IByK)

to find the best plan for a utility to meet its obligations.[14] It assures adequate power generation by modeling the use of power plants as needed to meet peak load with a reserve margin. It finds the lowest cost to supply needed power by “dispatching” the plants with lowest operating cost to satisfy load in each hour and by “building” new power plants (or alternative technology that provides megawatt-hours generation or “negawatt-hours” of demand reduction) of the kind and location that minimize the state’s total utility bill.

STEER can be run for each individual compliance year from 2020 through 2030. Since STEER is run for a single compliance year, any “build,” be it a generation facility or energy efficiency deployment, is assumed to occur before the analysis year and is available for use in the analysis year. STEER is able to optimize for lowest cost of power supply while ensuring that total carbon emissions from the power sector are below Virginia’s target under this regulation. The logical flow of STEER is illustrated in the following diagram.

Figure 1. STEER Operational Flow Chart



STEER incorporates a wide variety of measures that are available to mitigate carbon emissions from Virginia’s power system. These include the following:

- Improving the fuel efficiency of existing power plants, based on either generic assumptions or plant- specific engineering studies, as available;
- Changing the dispatch order of power plants to preferentially run those that produce fewer carbon emissions per unit of electricity produced;
- Implementing more energy-efficient commercial and residential building codes;
- Implementing more demand response resources to lower demand peaks;

[14] AEE’s STEER model, specialized for Virginia, is available online at: https://info.aee.net/steer-virginia

- Implementing more energy performance contracting to reduce electricity consumption in buildings and campuses;
- Implementing utility energy efficiency programs beyond what is currently required by the state;
- Using smart grid technologies, including Volt-VAR optimization, to improve efficiency in electricity distribution networks;
- Promoting distributed renewable generation through net metering and similar practices;
- Reducing use of coal plants by substituting new, less carbon-intensive generation resources, such as:
  - Industrial cogeneration of heat and electricity using natural gas;
  - Utility-scale natural gas combined cycle plants;
  - New nuclear plants;
  - On-shore and off-shore wind farms;
  - Utility-scale solar installations;
  - Hydropower generators both at dams and in-stream at locations without impoundments and turbine retrofits to existing; impoundments;
  - Generators fueled by landfill gas or gas produced from anaerobic digesters;
  - Municipal solid waste plants;
  - Power plants fueled by biomass such as mill wastes, urban wood waste, agricultural residue;
  - Blending biomass with coal to fuel existing coal plants; and
  - Natural gas fuel cells;
- Using pumped storage or battery systems to make excess low-carbon power available at other times; and
- Changes in the amount of power exported by Virginia to other states.

STEER models the interactions of carbon mitigation measures by re-computing the effects of measures not yet chosen in light of measures already chosen. For example, heat rate improvements performed at an existing coal plant will affect the results of re-dispatch to natural gas generation elsewhere in the state.

Uses and Limitations of STEER

STEER can serve as a fast, straightforward model for regulators and stakeholders to use in the early stages of compliance planning. While utilities have proprietary software to analyze the ultimate state plan, STEER can help stakeholders crosscheck various proposals and assumptions on their own.

Although the STEER Model is a comprehensive modeling tool that uses the same underlying decision framework of proprietary modeling software packages used by utilities and grid operators, there are important limitations to note. The model does not consider transmission constraints when calculating the least-cost mitigation options. In addition, the model calculates the least-cost plan for the single year chosen by the user (in this case 2030), and the model does not aggregate year-by-year results over a period of time. Also, STEER is designed for individual states, not regions or regional transmission operator territories, although STEER does allow for the accounting of electricity imports and exports. Finally, as described above, STEER considers the full range of carbon mitigation technologies and services, but in a given state, some technologies or services might be technically available yet inaccessible due to existing policies. For example, demand response is a cost effective mitigation option in many states, yet the policy suite in some states does not allow for demand response. The user should be mindful of these limitations when considering the results of STEER.

Energy efficiency (EE) programs typically try to influence purchase decisions when equipment is to be replaced, so energy efficiency potential studies typically report the savings that can be achieved in the 10th year through continuous application of the program for 10 years. STEER treats energy efficiency potential in this way, and so will overstate energy efficiency potential if the programs are not operated continuously for the 10 years prior to the modeled year.

A Note About Data Sources & Assumptions

Virginia AEE relied upon publicly available data and projections from well-credentialed sources for our modeling. Below is a rundown of key data points, projections, and sources:

- **Load Growth:** The anticipated year-over-year growth in demand for energy can have a significant impact on compliance option. We employed PJM's 2017 load growth assumption for the Dominion service territory.[15] This independent system operator has the objectivity, historical perspective, and analytical capability necessary to create a reliable projection of future load growth within the Commonwealth.

- **Energy Prices:** We utilized the National Renewable Energy Laboratory's (NREL) 2017 Annual Technology Baseline (ATB), which employs data around capital expenditures, operations and maintenance (O&M), and capacity factors to determine the levelized cost of energy for a variety of generation sources into the future.[16] Where applicable, we chose technical resource groups (TRGs) reflective of Virginia's wind resources and mid-range capacity factors for solar resources.

- **Energy Efficiency Potential:** We used the projections of Virginia's energy efficiency described in the report "State Level Energy Efficiency Potential Estimates," developed by the Energy Policy Research Institute in

[15] https://www.pjm.com/~/media/library/reports-notices/load-forecast/2017-load-forecast-report.ashx
[16] https://atb.nrel.gov/electricity/2017/index.html?t=in

conjunction with the U.S. Department of Energy.[17] The report describes the “Economic Potential” of each state, which may not take into account administrative and other non-economic barriers to implementation. To be conservative, we assumed that the Commonwealth could achieve 50% of that potential.

Pathways to Carbon Mitigation

What is the best path for Virginia to meet its carbon mitigation goals?

Utilizing STEER, Virginia AEE has developed three scenarios to illustrate the options available to the Commonwealth as it seeks to identify a path forward. The scenarios that follow are not presented as optimal compliance pathways, but rather as examples of potential paths to carbon reduction.

Three Technology Deployment Scenarios

We employed STEER to explore three different carbon mitigation paths in Virginia. All three scenarios started from the same baseline (33 M tons in 2020) and utilized the same assumptions regarding load growth. The different combination of mitigation technologies employed in each scenario are described briefly below, followed by a discussion of the least-cost technology choices that each produces.

- **Traditional Resource Scenario:** Energy planners have historically relied on fossil-fuel and nuclear resources to meet the vast majority of system needs. For our first scenario, we modeled least-cost compliance options using solely traditional resources, effectively negating the use of advanced energy resources, such as renewables and end-user energy efficiency.

- **Renewable Resource Scenario:** For our second scenario, we expanded the range of mitigation measures to include renewable generation. We assumed that end-user energy efficiency would not be employed as a mitigation option.

- **Diversified Resource Scenario:** For our third scenario, we expanded the range of options to allow for the use of supply-side resources, both traditional and renewable, and end-user energy efficiency (EE) – effectively the full suite of advanced energy technologies.

Using the parameters described above, we modeled the least-cost compliance path for each of the three scenarios. Altering the range of available technologies changes the least-cost compliance path in each scenario. The table below lays

[17] https://www.epri.com/#/pages/product/000000003002009988/

out the percentage of mitigation achieved by an array of possible measures tracked by STEER.

Table 1 – Percentage of Mitigation Achieved by Possible Measures

	Traditional	Renewable	Diversified
Heat Rate Improvement	8%	4%	4%
Coal to Gas Switching	83%	38%	44%
New Build Natural Gas	0%	0%	0%
Renewable Generation	0%	55%	9%
Energy Efficiency	0%	0%	39%
Network Efficiency	8%	4%	4%
Fuel Cells	1%	0%	0%

This side-by-side comparison guidance for regulators, system planners, and other stakeholders to consider on a number of options:

- **No New Build-Out of Natural Gas Generation:** Although the development of new natural gas-fired generators was an option in all three scenarios, it was not chosen based on price. This indicates that building new natural gas generation is not a cost-effective means of meeting Virginia's carbon mitigation goals, based upon projections of the levelized cost of energy developed by NREL.

- **Coal-to-Gas Switching:** Coal-to-gas switching – increasing the use of existing natural gas generating capacity and reducing the use of coal capacity – is chosen in all three scenarios. This would suggest that Virginia has underutilized natural gas generating capacity that it can use to meet electricity needs cost-effectively while reducing emissions.

- **Diversified Resources:** Modeling showed that renewable energy was a more cost-effective means of carbon reduction compared with traditional generation options, and a mixed portfolio of energy efficiency and renewable energy was lowest-cost when all resources are available.

Emission Results

Using STEER, we modeled emissions from covered energy generating units (EGUs) in 2030 to determine whether, and to what extent, the compliance options mapped in the three scenarios allowed the Commonwealth to meet its 2030 mitigation target of 23.1 million tons CO_2.

DEQ has proposed two possible 2020 baselines for the program – 34 million tons of CO_2 or 33 million tons. In our preliminary modeling, we examined both potential baselines to determine whether they made a meaningful difference in Virginia's ability to meet its 2030 target, and whether such a choice significantly altered the economic impacts of compliance pathways. We found that the different baseline did not change such outcomes, although it does alter the total CO_2 emissions from EGUs in 2030. As a result, for each of the three scenarios presented, we started with a 2020 baseline of 33 million tons CO_2.

The table below lays out the 2020 and 2030 emissions by covered EGUs under the three compliance scenarios, as calculated by STEER.

Table 2 – Total CO_2 Emissions by EGUs (in million tons) 2020 and 2030

	Traditional	**Renewable**	**Diversified**
2020 Baseline	33.0	33.0	33.0
2030 Emissions	28.5	19.7	19.7

This side-by-side comparison of the three scenarios generates a number of useful insights:

- **2030 target is readily achievable:** When advanced energy resources are employed, Virginia easily meets its 2030 carbon target. In fact, the Commonwealth achieves 3.4 million tons of additional CO_2 reductions below its 2030 target of 23.1 million tons.

- **Traditional resources fall short:** Using solely traditional resources, STEER was not able to identify an effective pathway to Virginia's 2030 emissions target regardless of the 2020 baseline. This result (28.5 million tons in 2030) leaves EGUs 6.1 million tons short of the 23.1 million ton goal. This result demonstrates the necessity of using advanced energy in a cost-effective path to carbon mitigation for Virginia.

Electricity Rate Results

The choice of compliance options will impact the rates that consumers pay for electricity, especially when it comes to generating resources. Although rates are an important factor for regulators and consumers to consider, they should not be the sole metric for evaluating compliance impacts. Stakeholders should also consider the total bills consumers pay for their energy use. For example, the deployment of demand-side resources – such as energy efficiency and distributed generation – can have countervailing impacts, at once raising *rates* as program costs are factored in, while lowering *bills*, as end-use consumers shift and reduce energy consumption. A focus solely on rates hides these benefits.

The table below presents potential changes in the electricity rate, in 2030, under the three scenarios. To show true economic impact, we have translated these rate changes ($/kWh) to average monthly volumetric costs for residential consumers. According to the latest data available from the EIA's Residential Energy Consumption Survey, the average Virginia household uses approximately

14,000 kWh per year, or approximately 1,172 kWh per month.[18] Under these scenarios, meeting carbon goals would cost households an extra $22 a month under the Traditional Scenario, add $7 a month in the Renewable Resources Scenarios, and save $1.16 per month in the Diversified Scenario, which includes renewables and energy efficiency.

Table 3 – Electricity Costs for Residential Consumers (2030)

	Traditional	Renewable	Diversified
Change in Rate	$0.019 / kWh	$0.006 / kWh	-$0.001 / kWh
Change Avg. Res Charge	$22 / month	$7 / month	-$1.16 / month

This side-by-side comparison of our three compliance scenarios sheds light on the rate impacts of different mitigation options:

- **Carbon mitigation can reduce rates:** Contrary to the assumptions of some stakeholders, an effectively implemented compliance plan for carbon reduction can lower rates to consumers and, more importantly, lower total utility bills. As the rate reductions achieved under the Diversified Resource Scenario demonstrate, a suite of mitigation options, including energy efficiency, renewables, and coal-to-gas switching, can result in rate and bill reductions for consumers.

- **Renewables more cost-effective than new traditional resources:** Looking at just generation resources, including renewable energy in the resource mix is more cost-effective to carbon mitigation than adding more gas-fired generation on top of coal-to-gas switching. Indeed, the impact to ratepayers from using solely traditional resources is roughly three times that of our Renewable Resources Scenario, which uses both traditional and renewable resources.

Employment Results

Energy is an important component of Virginia's economy. Any carbon mitigation approach is likely to reshape the composition of the industry, as the value of specific resources rises or falls. STEER allows us to track these changes, taking into account both the creation of new capacity and the increased or decreased utilization of existing capacity. The tables below present these changes.

Table 4 considers the addition of new capacity by 2030. As we do not see the new construction of natural gas units (nor coal) in any scenario we modeled, this table considers only additions to wind and solar capacity.

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[18] https://www.eia.gov/consumption/residential/

Table 4 – Generating Capacity Additions (cumulative - 2030)

	Traditional	Renewable	Diversified
Wind	0	800	300
Solar	1,000	11,000	1,000

It is worth noting, as demonstrated above, that STEER does not account for policy choices made outside a strictly economic context. As a result, the planned 5,000 MW of new large-scale renewable capacity recently determined to be "in the public interest" (per SB. 966) is underrepresented in both the Traditional and Diversified Resource scenarios.

Table 5 reviews the generation in 2030, as calculated by STEER, from affected generating resources (i.e. resources that see an increase or decrease in utilization) measured in terawatt hours (TWh). It takes into account, where appropriate, the addition of new capacity. For coal and natural gas, however, these changes reflect switching from one to the other.[19]

Where relevant, end-use energy efficiency (EE) is presented as a generation resource here. The savings achieved are shown in TWh hours in 2030, as if it were a new form of generation on the grid, allowing for an apples-to-apples comparison necessary to draw broader conclusions regarding its impacts.

Table 5 – 2030 Generation (TWh)

	Traditional	Renewable	Diversified
Coal	23.7	16.2	16.2
Nat Gas	25.5	20.0	22.1
Wind	0	2.7	1.1
Solar	1.3	15.0	1.3
EE	0	0	7.9

These changes, brought about both by the introduction of new resources (on both the demand and supply side) and shifts in the utilization of existing capacity, will impact employment in Virginia's energy sector.

For the purpose of these comments, we are focused solely on direct employment impacts – construction and installation jobs created through new resources, and operations and maintenance (O&M) jobs gained and lost due to shifting capacity utilization. As such, this analysis may underreport economy wide-impacts. While real, such indirect and induced employment effects can be difficult to determine.

[19] Although renewable generation is not used as a compliance pathway in the Traditional scenario, we still see the build out of roughly 1 GW based purely on competitive economics.

To calculate these employment impacts, we utilized data on energy sector employment first developed by the Environmental Protection Agency and published in AEE's 2015 report "Assessing Virginia's Advanced Energy Future", as well as on-the-ground experience from renewable developers in Virginia.[20] The table below lays out construction and O&M jobs tied to each relevant type of generation. These are conservative estimates for the job creation from renewable generation. Anecdotal evidence from developers operating in the state suggests job numbers may be significantly greater.

Table 6 – Construction and O&M Jobs by Generating Resource

	Construction Job Years / MW	O&M Jobs / Year / MW
Coal	N/A	0.14
Natural Gas	N/A	0.05
Wind (Onshore)	0.91	0.06
Solar (Lrg Scale)	3.61	0.04

To calculate the job gains tied to the implementation of end-use efficiency, we used data drawn from analysis conducted by ICF International and also listed in the AEE report "Assessing Virginia's Advanced Energy Future." ICF modeling estimates that an average capital costs $509 per MWh saved from EE between 2020 and 2030. Each million dollars invested, in turn, is estimated to produce seven new job-years. As these jobs cover a wide range of activities, from installation of new, more energy efficiency systems to maintenance and repair, we have not broken them out between the construction and O&M categories.

Using the data above, we calculated the direct effects of the three scenarios on employment in the energy industry. All jobs are measured in job-years – a new construction job is considered to be one job-year (a moderate to conservative assumption depending on the nature of the project) – allowing us to calculate the cumulative impact of these changes across both construction and O&M jobs. The table below presents the results of this analysis:

Table 7 – Employment Impacts by Deployment Scenario (Job-Years)

	Traditional		**Renewable**		**Diversified**	
	Construct	O&M	Construct	O&M	Construct	O&M
Coal	0	-224	0	-348	0	-348
Nat Gas	0	63	0	26	0	38
Wind	0	0	728	48	273	18
Solar	3,610	40	39,710	440	3,610	40
EE	0		0		28,014	
Cumulative	3,489		40,604		31,645	

[20] https://info.aee.net/virginia-energy-future

Side-by-side analysis of the employment changes under the three scenarios produces a number of takeaways:

- **Carbon Mitigation Creates Jobs:** We see net jobs gains regardless of the compliance pathway chosen. These gains are particularly significant – between 31,000 and 40,000 job-years – when system planners utilize advanced energy resources to meet emissions targets.

- **Gains & Losses Are Not Equally Felt:** Although in all scenarios we see job gains those gains are not equally felt. The impact of carbon mitigation falls disproportionately on those working in coal-fired generation, as the shift towards natural gas, renewables, and efficiency occurs. Policymakers should be conscious of such inequities as they seek to address potential changes from any mitigation plans.

Economic Results

The introduction of advanced energy resources can also be a source of new investment, as well as state and local tax revenue. Employing data from renewable energy developers in the state, we developed a high-level analysis of the total new investment and tax revenue (over the lifetime of a project), from wind and solar projects in the Commonwealth, based upon anticipated build-out calculated by STEER (see Table 8 below). We likewise estimated the investment figures for EE projects based on the ICF data referenced above.

Not all investment in a project remains in-state. Key wind and solar components, for example, must be procured from out-of-state. As a result, we estimate that 20% of investment in wind projects remains in state, and 25-33% for solar projects. We likewise assume that 20% of the investment in an efficiency project remains in state - a conservative figure as a number of notable EE companies are based in Virginia. Our analysis likely also undercounts new state and local tax revenue, as we were not able to determine the potential for new revenue from EE investments given their diversity and uncertainty around changes in property valuation based upon such investment.

Table 8 – New In-State Investment, State & Local Tax Revenue (in millions)

	Traditional		Renewable		Diversified	
	Investment	Tax Rev.	Investment	Tax Rev.	Investment	Tax Rev.
Wind	$0	$0	$235	$147	$88	$55
Solar	$399	$25	$4.39B	$275	$399	$25
EE	$0	N/A	$0	N/A	$800	N/A
Total	$399	$25	$4.62B	$422	$1.29B	$80

This side-by-side data should provide businesses, policymakers, and other stakeholders with a number of useful insights, including:

- **Carbon Mitigation is an Economic Win:** All three scenarios yield economic gains, in the form of new in-state investment and tax revenues. These investments range from approximately $400 million to over $4.6 billion in these scenarios, while new tax revenues range from $25 million to over $425 million. We see particularly pronounced new investment and tax revenue in the scenarios where advanced energy resources are utilized for compliance.

- **Unequal Gains are Good News:** Based upon broad industry experience, we should expect to see three groups net a disproportionate share of the economic gains from this new investment and revenue: construction, manufacturing, and rural communities. The construction industry benefits from an uptick in demand for skilled and unskilled labor to build new projects. Virginia manufacturers see an uptick in demand as developers and installers seek to source materials from local providers. And rural communities with available land and resources profit from a new source of long-term tax revenue. Each of these groups has been hard-hit by local and national economic trends in recent decades, so these potential benefits for should be of particular import to policymakers.

Section Three

Key Takeaways & Recommendations

As the STEER modeling in Section Two demonstrates, if planners, regulators, policymakers, and other stakeholders utilize advanced energy to meet carbon mitigation targets, and facilitate its deployment through effective policies and regulations, Virginians will enjoy an array of benefits, including:

- CO_2 emission reductions well below the 2030 targets proposed;
- Largely unchanged, and potentially reduced, electricity rates as savings from EE defray the need for new infrastructure investments
- 30,000–40,000 new job-years in construction, operation, and maintenance of new renewable energy systems and EE projects;
- Between $1.3 billion and $4.6 billion in new in-state investment;
- $80M to $420M in new state and local tax revenue from renewable projects.

Below we have put forward a series of recommendations – based upon our modeling and the experience of AEE in other states with carbon mitigation programs – in an effort to further strengthen the proposed regulation and better ensure these potential benefits come to fruition.

2020 Baseline: No More Than 33 Million Tons

Our analysis (see Table 1 in Section Two) indicates that, utilizing a diverse energy mix, the Commonwealth will not only meet, but come in well below, its 2030 target at little to no additional cost to consumers. Given the benefits of compliance, noted above, we recommend that DEQ set the 2020 baseline at no more than 33 million tons.

In addition, we suggest that DEQ consider setting the 2020 baseline below 33 million tons. Lowering that baseline may incent system planners and grid operators to accelerate the deployment of advanced energy resources in preparation for the 2030 targets. Such accelerated deployment is especially beneficial to ratepayers, as it would take advantage of the federal production tax credit (PTC) for wind – set to phase out by 2020 – and the investment tax credit (ITC) for solar and other advanced energy technologies, which declines to 10% by 2022. These federal financial incentives lower the costs of renewable resources, savings that will in turn be passed along to energy consumers. Furthermore, given the cost-effectiveness of EE, the sooner it is deployed the greater the cumulative savings will be to Virginia ratepayers.

Accelerate the Reduction Rate to 4%

Our modeling also indicates that, using a portfolio of advanced energy technologies in conjunction with coal-to-gas switching, Virginia can beat its 2030 carbon reduction target by approximately 3.4 million tons. These results suggest that actual reductions will exceed targets. When emissions reductions outstrip targets it has the effect of lowering the price of a carbon credit. While keeping the price of credits in check is preferable, significantly depreciating them – and potentially prompting an out-of-market intervention to prop up prices through the Emission Containment Reserve (ECR) – is not, as it depresses the market and introduces volatility.

We support the proposed establishment of both the Cost Containment Reserve (CCR) and the ECR, as the two, in combination, ensure that carbon prices remain within a predictable range throughout the compliance period. For our businesses, however, we prefer predictable and robust prices established and maintained through the market, as opposed to out-of-market interventions. Such prices are essential to the effective financing of advanced energy projects.

Thus, to ensure that carbon prices are predictable and robust, we recommend that the rate at which the cap decreases each year be accelerated, to 4% annually, and that the ECR and CCR be adjusted correspondingly. These changes will help ensure that targeted reductions and achieved reductions move in closer alignment, and that market functions proceed smoothly.

Reform the Allowance Allocation Method

One of the most important aspects of any carbon mitigation regulation is the allocation of credits. DEQ has taken steps in the right direction in the proposed legislation, but we recommend that the final regulation include an additional step to improve compliance and further facilitate emission reductions.

Under the proposed rule, all permits are allocated to generators (with the exception of the set-aside discussed below) based on a three-year rolling average of their net generation. We approve of DEQ's decision to base permit allocations on generation, as opposed to historic emissions, as well as the fact that allocations will be updated over time.

Nevertheless, a flaw in the proposal is that allocations are made only to "CO_2 budget units," which are defined as fossil-fired generators with nameplate capacity equal to or greater than 25 MW. To better incentivize compliance, we would recommend that the final rule allocate allowances to all generating units equal to or greater than 25 MW regardless of technology, as opposed to just fossil-fired EGUs. This method will ensure that the allowance allocation remains technology neutral and encourages competition among emission reduction measures. More information on this proposal can be found in the paper "A Performance Based Approach to Allowance Allocation" developed by the AEE Institute.[21]

Improve the Treatment of Combined Heat & Power (CHP) Systems

CHP units, as noted above, that generate heat and power for a specific individual facility (e.g. an industrial site) are exempt from the proposed regulation. Given the efficiency of such advanced energy systems, and the corresponding emissions benefits, we concur with other stakeholders that this exemption is reasonable.

The drafting of the proposed regulation, however, may inadvertently fail to exclude facilities that should reasonably be exempt. Therefore we would recommend that the phrase "owned by an individual facility" be removed from the regulation when finalized. This will ensure that CHP systems that serve an individual facility are exempt, regardless of their ownership status.

Simultaneously, we would also recommend that the phrase "for the primary use of operation of the facility" be more rigorously defined. In order to ensure that the "primary use" of the CHP system is indeed to serve the individual facility, the regulation to specify that a minimum of 85% of the useful energy output (thermal and electric) be used at the site. This requirement should ensure that covered entities don't attempt to game the exemption.

[21] https://info.aee.net/allocation-for-clean-power-plan-compliance

Finally, we would recommend that regulators carefully consider how emissions, created in the production of useful thermal energy from non-exempt CHP units, are treated. As currently proposed, a covered CHP system must account for emissions created in the production of both electricity and useful thermal energy. However, absent a CHP system, such thermal energy would be generated through a conventional method, such as a standalone boiler. Such convention methods are not subject to the regulation – potentially producing a perverse incentive that discourages the use of CHP while creating new emissions from non-covered sources. Virginia regulators should therefore consider the Useful Thermal Energy Exemptions put forward by other states currently participating in carbon budget trading programs.

Double the DMME Set-Aside

Under the current proposal, five percent of the base budget of conditional allowances would be set aside for the Virginia Department of Mines, Minerals, and Energy (DMME) or its designee, to assist in the Department in the abatement and control CO_2 emissions.

Virginia AEE supports this proposal. DMME is well positioned to effectively implement emission abatement activities, such as energy efficiency (EE) programs. According to recent studies by EPRI, by 2030 cost-effective energy efficiency programs have the potential to save Virginians over 23,000 gigawatt hours of generation, more than 17% of the state's load, each year.[22] On Virginia's current trajectory, however, the Commonwealth will achieve just 5% of that potential (i.e. 5% of 17.4%, or less than 1% of total load).

This underperformance stems from not only an underinvestment in EE but also, and more fundamentally, a misalignment of incentives. Reducing Virginia's load growth can indirectly undercut a utility's bottom-line by lessening the need for new investments. Yet to date, utilities remain key implementers of EE measures in the Commonwealth. Until this misalignment is reformed we support allowing experienced parties the ability to implement programs in addition to the utilities.

Unfortunately, the current set-aside is insufficient to allow for the robust implementation of such programs by DMME. We recommend a doubling of this set-aside, to 10%, in order to provide a more robust financing stream. As the analysis included in these comments demonstrates, EE is the lowest-cost mitigation option available. At it's current level it is more likely that low-cost EE measures are not utilized, increasing the cost of compliance to ratepayers.

As this percentage increase does not change the overall availability of credits in the marketplace, our modeling indicates that doubling the set-aside would not

[22] EPRI, *State Level Electric Energy Efficiency Potential Estimates* (Technical Update, May 2017). Available at: https://www.epri.com/#/pages/product/000000003002009988/

impact rates. Moreover, the implementation of such EE measures can help reduce overall customer bills, helping to alleviate any potential rate increases.

Utilize the National Energy Efficiency Registry

According to the modeling presented above, EE has the potential to help Virginia meet its carbon mitigation targets while reducing rates, creating jobs, and stimulating new in-state investment. As noted previously, we support the robust implementation of EE measures by a variety of parties, including DMME. The challenge EE presents, however, lies in the ability of system planners, regulators, and other stakeholders to effectively track, evaluate, measure, and verify the energy savings produced by an array of EE programs and measures.

In 2015, a set of states – Tennessee, Georgia, Michigan, Minnesota, Oregon, and Pennsylvania – came together with specialists from The Climate Registry and the National Association of State Energy Officials (NASEO), E4TheFuture, and APX, to develop a solution. They pioneered the National Energy Efficiency Registry (NEER), a web-based platform that helps states track and verify EE savings and transform those savings into tradable instruments parties may then use for compliance.[23]

We recommend that regulators and other interested stakeholders use NEER to facilitate the administration and tracking of EE programs in the Commonwealth. Employing consistent and well-established methods for evaluation, monitoring, and verification of savings will help Virginia confidently and effectively tap into this cost-effective resource, which is woefully underutilized at present.

Avoid Adverse Impacts on Voluntary Emission Reduction Markets

Virginia should design its emission reduction regulations so as not undermine market-based expectations for the carbon emission contributions of voluntary purchases of renewable energy. Voluntary purchasers of renewable energy, including purchasers of RECs, have done so at least in part based on the carbon reduction benefits of purchasing that electricity. In many states, the purchase of a REC has historically included the purchase of environmental attributes associated with the carbon reductions of that power.

Unless the voluntary market is taken into account, a statewide carbon reduction requirement could unintentionally undermine these voluntary purchaser commitments because voluntary purchases of renewable energy will no longer represent a "regulatory surplus" of emission reductions. [24] A number of existing

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[23] For additional information on NEER, visit: http://www.theclimateregistry.org/thoughtleadership/energy-efficiency/

[24] *See* Cal. Code Regs. tit. 17, § 95841.1 (outlining the California Cap-and-Trade Program Voluntary Renewable Electricity allowance set-aside); Regional Greenhouse Gas Initiative Model Rule at 44-47 (Dec. 23, 2013), available at

emission reduction programs have avoided this outcome through the establishment of a voluntary purchaser set-aside in which allowances are allocated to power purchasers that have committed to pay for emission reductions through voluntary clean energy purchases.

Alternatively, as Virginia AEE proposes above, this can be done by allocating allowances to resources that *reduce* emissions rather than only to emitting resources. Doing so will allow advanced energy resources to fulfill any contracted-for obligations to transfer allowances to purchasers under existing power purchase agreements. Those purchasers can then choose to do what they wish with the allowances they have already contracted for. This gives purchasers the choice to retain these allowances if they wish to preserve the project's "regulatory surplus."

Conclusion

There is a clear and compelling economic case for the establishment and implementation of a carbon mitigation program by the Commonwealth. It has the capability to generate new jobs, in-state investment, and tax revenues for the decade to come.

The degree to which Virginia meets its emissions targets and reaps the corresponding environmental and economic benefits hinges on the robust utilization of advanced energy technologies. Renewable generation energy efficiency, demand response, and other innovations offer the opportunity to reduce emissions while also creating a more reliable, resilient grid and saving money for businesses and residents.

Virginia AEE appreciates the opportunity to comment on the proposed rule. We look forward to working with the Department of Environmental Quality and other stakeholders as this process continues.

Sincerely,

Harrison Godfrey
Executive Director
Virginia Advanced Energy Economy

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http://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_FINAL.pdf (outlining a similar set-aside under RGGI).